Advanced
Materials
Solutions

Department of Energy SBIR Phase I: Advanced Tungsten Structures for Plasma-Facing Components in Magnetic Confinement Fusion Energy Reactors

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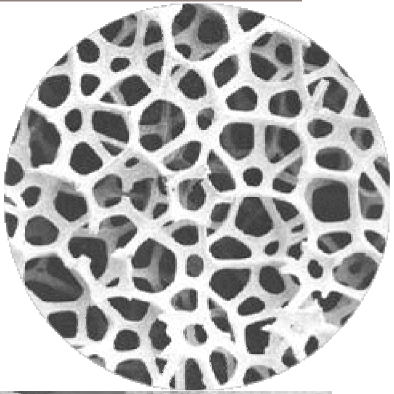
Program Duration: 9 Months, Starting June 27, 2005

Program Goal

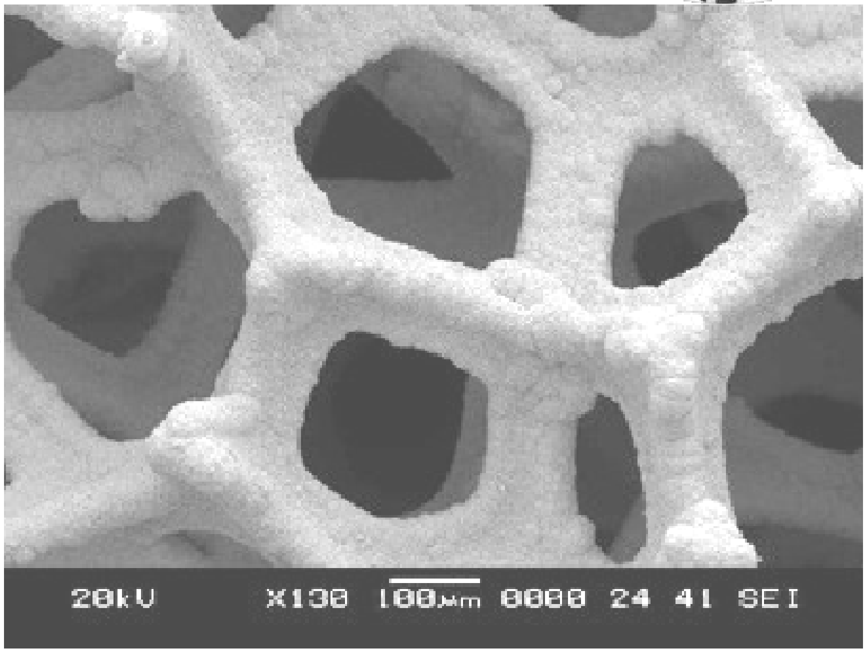
- The primary objective of this project is to develop and demonstrate the initial feasibility of innovative refractory materials and structures that will allow for extended fusion energy system steady-state operation at heat flux levels greater than 15 MW/m^2 and be capable of surviving brief excursions to 1 MJ/m^2.

Approach & Potential Design Benefits



- **Ultramet will fabricate an ultrahigh temperature heat exchanger composed of a thin tungsten shell integrally bonded to an open-cell tungsten foam core, which will provide both the primary mechanical structure and extremely efficient coolant channels for thermal control of critical components.**

- **<u>Less Complex</u>: Foam structure is inherently porous, therefore no intricate and expensive machining of coolant passages is required.**
- **<u>Heat Transfer:</u> W Foam heat exchanger is metallurgically bonded to the solid CVD W hot wall for optimal heat transfer.**
- **<u>Durability:</u> High stiffness, W foam structures have greater resistance to mechanical and thermal shock than solid W.**



SEM micrograph of 100-ppi tungsten foam

Phase I Statement of Work (6/27/05-3/26/06):

- **Task 1: Thermomechanical Modeling**

  - Performed by DMS to establish thermomechanical durability and heat transfer characteristics for use in planning and analyzing high heat flux experiments at Sandia.

- **Task 2: Heat Exchanger Fabrication**

  - Tungsten foam/tungsten shell composite heat exchangers (nominally 6-8" long × 0.5" diameter) will be fabricated by Ultramet based on the properties defined in Task 1.
  - Materials Characterization at Ultramet: SEM, EDS, XRD

- **Task 3: High Heat Flux Testing and Analysis**

  - The tungsten heat exchangers will be tested in the 30-kW electron beam test system (EBTS) at Sandia using helium coolant. A thermal response curve will be generated illustrating surface temperature vs. input power at various mass flow rates, from which the effective heat transfer will be determined.

- **Task 4: Reporting**